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INFORMATION ON ATLANTIC STURGEON FOR THE REFINEMENT OF DISSOLVED OXYGEN CRITERIA

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GENERAL LIFE HISTORY

1. Long-lived, late maturing anadromous fish
2. Range from the Hamilton River, Labrador to Port Canaveral, Florida
3. NMFS listed five DPSs under the ESA
   - Endangered: New York Bight, Chesapeake Bay , Carolina, and South Atlantic populations
   - Threatened: Gulf of Maine population
4. Utilizes a wide variety of habitats
   - Spawning: tidal freshwater areas of estuaries above the salt front
   - Egg and Larvae (< 30 mm TL) Development: freshwater areas above the salt front
   - Juvenile (> 41 cm to <76 cm TL) Development: freshwater areas to 27.5 ppt tidal and estuarine areas of natal river. Remain in natal rivers for 1- 6 years.
   - Subadult (> 76 cm to < 150 cm TL) and Adult (> 150 cm TL) Foraging: marine environment making long distances migrations along coastline and between estuaries.

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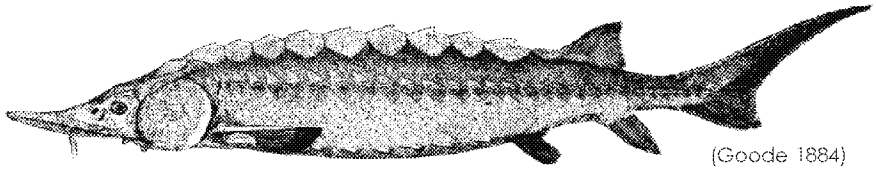
GENERAL LIFE HISTORY

5. Sexually maturity varies with latitude
   - South Carolina: Males as early as 5 years, females as early as 7 years
   - Hudson River: Males between 8-19 years, and females between 15-20 years
   - St. John River, Canada: Males between 16–24 years, females between 17–28 years
6. Maximum recorded age is 60 years (267 cm TL)
7. Migrations
   - Adults make seasonal migrations to and from freshwater spawning habitats
   - Large-scale southerly fall migrations and northerly spring migrations

(Green et al. 2009)



(Goode 1884)

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MOUNT HOPE BAY AND THE TAUNTON RIVER

1. Historically: Spawning occurred in the Taunton River at the turn of the 20th century. Common in traps set off Sakonnet from May through November (Tracy 1905)
2. Last reported sightings in the Taunton River occurred in 1992 when two subadults (91 cm and 100 cm TL) were collected (Buerkett and Kynard 1993)
3. The Taunton River is unlikely to have an annual spawning population (Buerkett and Kynard 1993)
4. Taunton River up to the convergence of the Town River and Matfield River provides foraging habitat for subadult and adult Atlantic Sturgeon (GARFO 2017)

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DISSOLVED OXYGEN REQUIREMENTS

1. Unusually sensitivity to low oxygen concentrations
2. Earliest life stages are the most sensitive to DO levels
3. DO is known to be an important habitat parameter for YOYs and juveniles
   - Mortality occurred only under hypoxic (3 mg/L) conditions, with a 21.7% mortality observed at 19° C and a 93.7% mortality observed at 26° C. DO levels of 3 mg/L resulted in a threefold reduction in growth rate and a 50% reduction in respiration rate compared to normoxic (7 mg/L) conditions (Secor and Gunderson 1998)
   - YOY aged 30 to 200 days would experience a loss in growth in habitats with less than 60% DO saturation. This level corresponds to 4.3 mg/L to 4.7 mg/L at temperatures of 22°C to 27°C (Secor and Niklitschek 2002)

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DISSOLVED OXYGEN REQUIREMENTS

- Maximum growth and food consumption rates were observed above 70% DO saturation, at 20 °C, and between salinities of 8 and 15 ppt. A 70% DO saturation is equivalent to 7.9 mg/L at 12 °C, 6.7 mg/L at 20 °C (Niklitschek and Secor 2009).
- Estimated YOY mortality was two times higher at 30% DO saturation than at 40%, and four times higher than at 70% DO saturation (Niklitschek and Secor 2009).
- Additive and synergistic effects of temperature, salinity, and dissolved oxygen on sturgeon physiological responses (Niklitschek and Secor 2009).

4. Recommended habitat conditions thresholds for successful recruitment in the Delaware River are an instantaneous DO ≥ 5.0 mg/L, temperatures < 28 °C and salinity < 0.5 ppt (Moberg and DeLucia 2016).

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DISSOLVED OXYGEN REQUIREMENTS

5. Culture manual recommendations:
   - First-feeding fry and fingerlings (about 0.3 grams to age-1 fish) should be maintained at dissolved oxygen levels of 8 mg/L or more
   - Newly captured, stressed broodstock (adult) sturgeons should be maintained at DO levels greater than 80% saturation
   - For long-term captivity, broodstock sturgeons should be in DO levels greater than 6 mg/L (Mohler 2003).
6. NMFS capturing and handling recommendations:
   - Do not capture or handle Atlantic Sturgeon when DO concentrations are below 4.5 mg/L.
   - Do not sample Atlantic Sturgeon when temperatures exceed 28°C or when oxygen saturation is below 55% (Kahn and Mohead 2010).

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OTHER STURGEON SPECIES

1. All sturgeon species survival is affected by a relationship between temperature, DO, and salinity (Jenkins et al. 1993, Secor and Gunderson 1998, Secor and Niklitschek 2002)
2. Shortnose Sturgeon (*Acipenser brevirostrum*)
   - The 24-hour LC_{50} for 77 day old fish was 2.7 mg/L (32% saturation) at 25 °C and 2% salinity and for 104 day old fish, 2.2 mg/L (26% saturation) at 22 °C at 4% salinity. The 24-hour, 48-hour, and 72-hour LC_{50} values were also 2.2 mg/L (28% saturation) for 134 day old fish at 26 °C and 4.5% salinity. The LC_{50} for 100 day old fish was 3.1 mg/L at 30 °C and 2% salinity (Campbell and Goodman 2003).
   - Based on these findings, EPA (2003) calculated DO concentrations to be protective of sturgeon exposed to both non-stressful and stressful temperatures and estimated a DO concentration of 4.3 mg/L should be protective under stressful temperatures.

OTHER STURGEON SPECIES

- In acute 6-hour hypoxia experiments an 86 - 100% mortality was observed for YOYs and an 12-20 % mortality in juveniles exposed to 2.5 mg/L DO at 22.5 °C (30% saturation). Short-term exposure to 3.0 mg/L (35% saturation) resulted in 18 - 38% mortality for juveniles. No mortality was observed when DO levels were at or above 4.0 mg/L (Jenkins et al. 1993, Secor and Niklitschek 2002).
- Reductions in YOY Shortnose Sturgeon routine metabolism, consumption, feeding metabolism, growth, and survival occurred at 40% DO saturation compared to 70% saturation (Niklitschek 2001, Secor and Niklitschek 2002).
- YOY Shortnose Sturgeon will experience lost production in habitats with less than 60% oxygen saturation (DO concentrations of 4.3 - 4.7 mg/L at temperatures ranging from 22° to 27 °C (Secor and Niklitschek 2002).

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OTHER STURGEON SPECIES

3. Eurasian Sturgeons (*Acipenser gildenstadtii, A. baeri, A, stellatus* and the hybrid *Huso huso* x *A. ruthensus*)
   - Critical DO concentrations ranged between 25-60% saturation, increasing with temperature. At 20°C, the critical DO concentration was 3.6 mg/L (42% saturation), and at 24°C, critical concentration was 4.5 mg/L (54% saturation; Secor and Niklitschek 2002).

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DESIGNATED CRITICAL HABITAT

1. For the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs

   …(4) Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:

   (i) Spawning;

   (ii) Annual and interannual adult, subadult, larval, and juvenile survival; and

   (iii) Larval, juvenile, and subadult growth, development, and recruitment… (82 FR 39160)

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DESIGNATED CRITICAL HABITAT

2. Critical habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs does not include a specific threshold for dissolved oxygen levels.
3. The NMFS stated in response to commenters that it did not specify optimal or suboptimal dissolved oxygen levels because there is not a single DO level or temperature range that is best for Atlantic Sturgeon in terms of habitat avoidance (82 FR 39160).
4. NMFS designated the instantaneous minimum DO levels needed to protect Atlantic Sturgeon in the Carolina and South Atlantic DPSs at 4.3 mg/L in water temperatures greater than 26 °C.

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SUMMARY

Life stage	Size[a]	Description[a]	Habitat	Occurrence	Dissolved Oxygen	Temperature (°C)	Salinity (ppt)
Eggs		Fertilized or unfertilized	Flowing water of rivers along the Atlantic coast. Eggs are adhesive and attach to hard substrate including gravel and cobble[b].	May - June in Massachusetts waters[c]	NA	Reported: Hatching occurs in 94 to 140 hours at water temperatures of 20° and 18°, respectively[b] Culture: 20-21 optimal[d]	Reported: Freshwater - found upstream of the salt front[b,e]
Larvae	< 30 mm TL	Nourished by yolk sac, negative phototaxis	Same habitat as eggs[b]	May - June in Massachusetts waters[c]	Culture: 8 mg/L or greater[d]	Reported: 15.0 - 24.5[c] Culture: 15.0 - 19.0[d]	Reported: 0 - 2.2[f]
YOY	< 41 cm TL	Fish that are > 3 months and < 1 year old, capable of capturing and consuming live food	Natal river over rocks, cobble, sand, and mud or transitional substrates[b]	August - April (based on description and larval occurrence in Massachusetts waters)	Culture: 8 mg/L or greater[d] Optimal: above 70% saturation[g] Acute and chronic lethal effects: ≤ 3.3 mg/L[h,i]	Sub-lethal: > 28[b,j]	0 - 15[g]
Juveniles	> 41 cm to <76 cm TL	Fish that are at least 1 year old and are not sexually mature, they do not make coastal migrations	Natal river over rocks, cobble, sand, and mud or transitional substrates[b]	Year round in natal river[b]	Optimal: above 70% saturation[g] Acute and chronic lethal effects: ≤ 3.3 mg/L[h,i]	Tolerate: 3 - 28, Optimal: about 20, Sub-lethal: > 28[b,j]	Reported: 0 - 27.5, Optimal: about 10[b]
Subadults	> 76 cm to < 150 cm TL	Fish that make coastal migrations but are not sexually mature	Estuarine and marine waters[b]	Year round[c]	NA	Sub-lethal: > 28[j,k]	Reported: 0 - marine waters[b]
Adults	> 150 cm TL	Fish that are sexually mature	Estuarine and marine waters, Spawning occurs in freshwater rivers[b]	Year round[c]	Culture: > 6 mg/L[d]	Reported in temperatures as high as 33.1 in South Carolina[b]	Reported: 0 - marine waters[b]

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TOPICS TO DISCUSS

1. MassDEP is considering the use of percent saturation for the DO criteria instead of concentration (mg/L). Percent saturation is a biologically relevant factor for hypoxia and represents what physically determines fish oxygen uptake from the surrounding water. It is expected to provide a better criterion for the ranges of temperatures and salinity that occur and are expected to occur in Mount Hope Bay and the Taunton River. Can the EPA provide any current guidance or recommendations for using percent saturation instead of concentration for DO criteria?

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TOPICS TO DISCUSS

2. MassDEP intends to be protective of Atlantic Sturgeon using information from published literature and results from the DO tolerance analysis of the resident assemblage, which includes Atlantic Sturgeon as a potential resident in the study area. Protective DO criteria should allow sturgeons to naturally reoccur in the study area.
3. In the review of proposed DO criteria, how will the EPA apply the critical habitat designation under the Endangered Species Act to locations where Atlantic Sturgeon could occur?

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